Medical Equipment II Term Exam – June 2010

Solve as Much as You Can – Maximum Grade: 50 Points

Part I. Answer these questions by marking the best answer among the choices given (1 point each):

1. The higher the static magnetic field, …
    a. The higher the signal-to-noise ratio (*)
    b. The lower the noise in the received signal
    c. The higher the resolution of the image
2. In order to better visualize the effect of an RF pulse on the magnetization vector, …
    a. Quantum mechanical description is used
    b. Spiral trajectory is used
    c. Rotating frame of reference is used (*)
3. It is possible to measure the net magnetization component, when …
    a. It is in the transverse (x-y) plane (*)
    b. It is precessing
    c. Applying an RF pulse
4. Slice selection gradient is applied when …
    a. The data are collected
    b. The RF pulse is applied (*)
    c. The readout gradient is not applied
5. The term “partial flip” is used when the flip angle is … degrees.
    a. Less than 90 (*)
    b. Exactly 90
    c. Less than 180
6. MR signal is collected … the RF pulse is applied.
    a. Before
    b. During
    c. After (*)
7. During relaxation, by the time Mxy becomes zero, Mz is …
    a. Still growing (*)
    b. Full
    c. Zero
8. A tissue with short T1 value appears … in a T1-weighted image.
    a. Dark
    b. Bright (*)
    c. Gray

9. A tissue with long T2 value appears … in a T2-weighted image.
    a. Dark
    b. Bright (*)
    c. Gray
10. It is possible to reverse the effect of magnetic field inhomogeneity on relaxation using …
    a. Spin-echo sequence (*)
    b. STIR sequence
    c. Partial saturation sequence.
11. Received MR signal appears like …
    a. A spiral trajectory
    b. Sinusoidal signal at Larmor frequency
    c. An exponentially decaying sinusoidal (*)
12. To get a T1-weighted image, we use …
    a. Short TR
    b. Short TE
    c. Both of the above (*)
13. The only contrast parameters that must exist in all imaging sequences is …
    a. Proton density (PD) weighting (*)
    b. T1-weighting
    c. T2*-weighting
14. Using a partial saturation sequence with a long TR and a long TE results in …
    a. T1-weighting
    b. T2*-weighting(*)
    c. T2-weighting
15. In … , edema appears bright while both gray matter and white matter appear isointense.
    a. T1W
    b. T2W
    c. PDW (*)
16. It is possible to suppress a particular tissue in MRI using … pulse sequence.
    a. Partial saturation
    b. Inversion recovery (*)
    c. Spin echo
17. To change the position of the selected slice in MRI, we change … of the RF pulse
    a. Modulation (*)
    b. Profile
    c. Bandwidth
18. Cross-talk between MRI slices is the result of imperfect …
    a. Slice profiles (*)
    b. Slice positions
    c. Slice modulation
19. For a tissue with T1= 500 ms, the inversion time (TI) that nulls its signal is equal to …
    a. 0.35 s (*)
    b. 0.69 s
    c. 1.44 s

20. Saturation means …
    a. All magnetization is in z direction
    b. All magnetization is in x-y plane (*)
    c. All magnetization is at equilibrium
21. If a slice selection gradient Gz and a Sinc RF pulse with bandwidth BW and modulation ω selects a slice of thickness 5 mm centered at position z= 2 cm, then to change the slice thickness at the same position to 2.5 mm, one must …
    a. Change slice selection gradient to 2 Gz (with all other parameters the same)
    b. Change modulation frequency to 2 ω (with all other parameters the same)
    c. Change slice selection gradient to 2 Gz and change modulation frequency to 2 ω with same bandwidth (*)
22. The safety zone in MRI suite is defined by …
    a. 0.5 mT line (*)
    b. Size of MRI suite
    c. Surrounding equipment in other rooms
23. The process in which the static magnetic field is brought to zero catastrophically is called …
    a. Shimming
    b. Quenching (*)
    c. Ramp-up
24. It is not recommended to install MRI systems to close to railway lines because …
    a. This will cause problems to trains
    b. This will affect MRI image quality (*)
    c. This will affect people riding the train who may be using pacemakers.
25. In pair production, momentum is conserved by taking … into account.
    a. Recoil of nucleus (*)
    b. Recoil of electron
    c. Recoil of positron
26. Above 2.04 MeV, … can occur.
    a. Compton scattering
    b. Coherent scattering
    c. Triplet production (*)
27. When a photon with energy $h\nu$ strikes an atom resulting in the emission of a photoelectron from the K shell, the excitation energy of that atom becomes …
    a. $h\nu$
    b. B_K (*)
    c. $h\nu-B_K$
28. For an atom with a hole in its K shell, when a radiative transition occurs a photon with energy … will be emitted.
    a. B_K
    b. B_K-B_L (*)
    c. $h\nu$
29. During the deexcitation of an atom with a hole in the K shell, if one Auger electron from the L shell and one L fluorescence photon were emitted, then the final excitation energy of that atom will be …
    a. B_K-B_L
    b. B_L (*)
    c. 0

30. Electron energy can be converted to photons using a process called …
    a. Deexcitation of atoms
    b. Auger cascade
    c. Bremsstrahlung (*)
31. The jump in photoelectric cross section at the K-edge is equal to …
    a. τ_K (*)
    b. τ_L
    c. $\tau_K+\tau_L$
32. The photoelectric cross section of a material is … that of a material with half its atomic number around 100 keV.
    a. Double
    b. 4 times
    c. 16 times (*)
33. In Compton scattering, we derive the angles and energies of the scattered electron and photon by solving …
    a. Conservation of energy and momentum in 2 directions (*)
    b. Special relativity
    c. Klein–Nishina Formula
34. The energy of a moving electron is related to its … using the special relativity.
    a. Kinetic energy
    b. Momentum and mass (*)
    c. Potential energy
35. The difference between Compton and incoherent scattering is that …
    a. Compton scattering involves only one electron (*)
    b. Compton scattering involves more than one electron
    c. Incoherent scattering must involve all electrons in the atom
36. The cause of chromatic aberration is …
    a. Variation of index of refraction of the lens with wavelength (*)
    b. Variation of index of refraction of the lens with distance from the axis of the eye
    c. Lack of accommodation from aging
37. In hyperthermia, the heated spot is cooled as a result of …
    a. Incident photons
    b. Blood perfusion (*)
    c. Tissue ablation
38. If the K-shell photoelectric cross section for 100-keV photons on lead (Z = 82) is $\tau = 1.76 \times 10^{-25}$ m^2/atom, then the photoelectric cross section for 60-keV photons will be …
    a. 8.15×10^{-25} m^2/atom (*)
    b. 3.8×10^{-26} m^2/atom
    c. 1.06×10^{-25} m^2/atom
39. If a 1-MeV photon undergoes Compton scattering with scattered photon having an energy of 500keV, then the scattering angle of the photon will be approximately …
    a. 30°
    b. 60° (*)
    c. 90°

40. A beam of 59.5-keV photons from ^{241}Am scatters at 90° from some carbon atoms (A = 12). The energy of a coherently scattered photon in this case will be …
    a. 34.6 keV
    b. 53.1 keV
    c. 59.5 keV (*)
41. According to Compton scattering equations for an incident photon of energy E, the maximum energy of the emerging photon will be …
    a. E (*)
    b. E/2
    c. $m_e c^2$
42. If the absorption coefficient of a human tissue is 10 m^{-1} and if this tissue has the density of water and a molecular weight of 18, the absorption cross section will be equal to …
    a. 15 x 10^{-29} m^2/particle
    b. 20 x 10^{-29} m^2/particle
    c. 30 x 10^{-29} m^2/particle (*)
43. If a relaxed eye focuses at a distance of 100 cm, the strength of the desired corrective lens should be … diopters.
    a. -1 (*)
    b. +1
    c. -2
44. For OCT in water, the coherence time needed for a spatial resolution of 2 µm should be …
    a. 2.2 fs
    b. 4.4 fs
    c. 8.8 fs (*)
45. A beam with 200 particles/cm^2 passes by an atom. If 50 particles are scattered in a cone of 0.25 sr solid angle about a particular direction, the differential cross section will be … cm^2/sr.
    a. 1 (*)
    b. 10^{-4}
    c. 5 x 10^{-5}

Part II. Mark the following statement as either True (T) or False (F) (0.5 point each):

46. All nuclei act like tiny bar magnets with random direction. (F)
47. It is possible to receive magnetic resonance signal without an RF pulse but it will be weak. (F)
48. Precession frequency at 1T changes from ^{1}H to ^{13}C. (T)
49. It is possible for Mz to take a negative value after an RF pulse. (T)
50. Relaxation time T2* is always longer than T2 for any given tissue. (F)
51. It is possible to use STIR sequence to null the water signal in a tissue. (T)
52. It is possible to find more than one MRI contrast mechanism to differentiate between two tissue types. (T)
53. Spin echo sequence can be used to compensate for spin-spin interactions in a tissue. (F)
54. Contrast in both partial saturation and inversion recovery sequences depends on T1 of the tissue. (T)
55. It is possible to select a slice defined between y=1cm and y=2cm using a gradient in the y-direction. (T)
56. One can control the slice thickness in MRI by changing the slice selection gradient. (T)

57. MRI slice profile can be computed as the Fourier transform of the tissue intensity. (F)
58. Mapping frequency to spatial location is the basis for Fourier encoding methods. (T)
59. Inhomogeneity of MRI magnets is measured using a ppm scale. (T)
60. Permanent magnets do not use shim coils. (F)
61. RF coils are used to generate magnetic field gradients in MRI. (F)
62. For a small clinic in the 3rd floor of a building, open MRI is a good option. (F)
63. Power consumption of MRI increases linearly with strength of magnetic field used. (F)
64. It is not possible to have a CT in the same building as MRI to avoid artifacts. (F)
65. Safety precautions on MRI suite location include the floors above and below the MRI location. (T)
66. Minimum energy for pair production to occur is 0.51 MeV. (F)
67. In broad-beam geometry, scattered photons may still reach the detector. (T)
68. The advantage of mass attenuation coefficient is that it varies only with Z/A. (F)
69. Radiative and non-radiative deexcitation mechanisms are two competing processes. (T)
70. Auger yield increases with atomic number. (F)
71. Peak of coherent scattering cross section is narrower for elements of lower atomic number. (T)
72. The cross section of coherent scattering is always peaked in the backscattering direction. (F)
73. Auger cascade is important because of its molecular bond breaking effect. (T)
74. Spherical aberration is different from astigmatism in that it is symmetric with angle around eye axis. (T)
75. Photometry is the process of measuring photon flux. (F)

Best of Luck!